

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in this application.

LISTING OF CLAIMS

1. (Currently Amended) A centrifugal blood pump apparatus comprising:
 - a housing having a fluid inlet port and a fluid outlet port;
 - a centrifugal pump section including an impeller having a first magnetic material therein and rotatable inside said housing to feed a fluid by a centrifugal force generated during a rotation thereof;
 - an impeller rotational torque generation section for attracting and rotating said impeller;
 - and a hydrodynamic pressure groove formed at a portion of an inner surface of said housing at an impeller rotational torque generation section side or at a portion of a surface of said impeller at said impeller rotational torque generation section side, said impeller being rotatable without contacting said housing owing to an action of said hydrodynamic groove,
 - an electromagnet for attracting said first magnetic material of said impeller or a second magnetic material provided on said impeller separately from said first magnetic material in a direction opposite to a direction in which said impeller rotational torque generation section attracts said first magnetic material and helping said impeller levitate; and
 - a control mechanism for controlling said impeller rotational torque generating section and said electromagnet, said control mechanism starting rotation of said

impeller rotational torque generating section with said electromagnet attracting said impeller thereto at a force not less than a predetermined value; and

wherein said impeller rotational torque generation section has a rotor having a magnet for attracting said first magnetic material of said impeller and a motor for rotating said rotor; and said hydrodynamic pressure groove formed at the portion of the inner surface of said housing at a rotor-disposed side or the portion of the surface of said impeller at said rotor-disposed side, and said electromagnet attracting said first magnetic material or the second magnetic material in a direction opposite to the direction in which said magnet of said rotor attracts said first magnetic material to help said impeller levitate.

2. (Canceled)

3. (Currently Amended) A centrifugal blood pump apparatus according to claim ~~[[2]]~~ 1, wherein said first magnetic material of said impeller and said magnet of said rotor for attracting said first magnetic material comprise a plurality of permanent magnets respectively; and said permanent magnets of said impeller are arranged in first and second different circumferential arrangements, and said permanent magnets of said rotor are arranged in first and second different circumferential arrangements, said permanent magnets forming the first circumferential arrangement of said permanent magnets of said impeller and the first circumferential arrangement of said permanent magnets of said rotor facing each other with opposite polarities, said permanent magnets forming the second circumferential arrangement of said permanent magnets of said impeller and the second

circumferential arrangement of said permanent magnets of said rotor facing each other with opposite.

4. (Previously Presented) A centrifugal blood pump apparatus according to claim 1, wherein said impeller rotational torque generation section has a plurality of stator coils, disposed circumferentially to rotate said impeller, for attracting said first magnetic material of said impeller of said centrifugal blood pump section; and said hydrodynamic pressure groove being formed at the portion of the inner surface of said housing at a stator coil-disposed side or at the portion of the surface of said impeller at said stator coil-disposed side thereof, and said electromagnet attracting said first magnetic material or the second magnetic material in a direction opposite to the direction in which said stator coils attract said first magnetic material and helping said impeller levitate.

5. (Previously Presented) A centrifugal blood pump apparatus according to claim 1, wherein the control mechanism changes a degree of an impeller-attracting force of said electromagnet according to a rotation speed generated by said impeller rotational torque generation section.

6. (Previously Presented) A centrifugal blood pump apparatus according to claim 5, wherein said control mechanism maintains a constant distance between said impeller and said housing by changing the degree of the impeller-attracting force of said electromagnet according to the rotation speed generated by said impeller rotational torque generation section.

7. (Canceled)

8. (Previously Presented) A centrifugal blood pump apparatus according to claim 1, wherein the control mechanism reduces an attractive force of said electromagnet to a value less than said predetermined value after said impeller rotational torque generation section starts to rotate.

9. (Previously Presented) A centrifugal blood pump apparatus according to claim 5, wherein said control mechanism monitors electric current of said impeller rotational torque generation section and controls said electromagnet by using an electric current value detected by said control mechanism.

10. (Original) A centrifugal blood pump apparatus according to claim 1, wherein a corner of said hydrodynamic pressure groove is chamfered to allow said corner to have a radius of rounding at not less than 0.05 mm.

11. (Original) A centrifugal blood pump apparatus according to claim 1, wherein said centrifugal blood pump apparatus has a second hydrodynamic pressure groove formed at a portion of an inner surface of said housing at a electromagnet-disposed side or at a portion of a surface of said impeller at said electromagnet-disposed side.

12. (Original) A centrifugal blood pump apparatus according to claim 11, wherein a corner of said second hydrodynamic pressure groove is chamfered to allow said corner to have a radius of rounding at not less than 0.05 mm.

13. (New) A centrifugal blood pump apparatus comprising:
a housing having a fluid inlet port and a fluid outlet port;
a centrifugal pump section including an impeller having a first magnetic material therein and rotatable inside said housing to feed a fluid by a centrifugal force generated during a rotation thereof;
an impeller rotational torque generation section for attracting and rotating said impeller;
and a hydrodynamic pressure groove formed at a portion of an inner surface of said housing at an impeller rotational torque generation section side or at a portion of a surface of said impeller at said impeller rotational torque generation section side, said impeller being rotatable without contacting said housing owing to an action of said hydrodynamic groove,
an electromagnet for attracting said first magnetic material of said impeller or a second magnetic material provided on said impeller separately from said first magnetic material in a direction opposite to a direction in which said impeller rotational torque generation section attracts said first magnetic material and helping said impeller levitate; and
a control mechanism for controlling said impeller rotational torque generating section and said electromagnet, said control mechanism starting rotation of said

impeller rotational torque generating section with said electromagnet attracting said impeller thereto at a force not less than a predetermined value; and

wherein said impeller rotational torque generation section has a plurality of stator coils, disposed circumferentially to rotate said impeller, for attracting said first magnetic material of said impeller of said centrifugal blood pump section; and said hydrodynamic pressure groove being formed at the portion of the inner surface of said housing at a stator coil-disposed side or at the portion of the surface of said impeller at said stator coil-disposed side thereof, and said electromagnet attracting said first magnetic material or the second magnetic material in a direction opposite to the direction in which said stator coils attract said first magnetic material and helping said impeller levitate.

14. (New) A centrifugal blood pump apparatus according to claim 13, wherein the control mechanism changes a degree of an impeller-attracting force of said electromagnet according to a rotation speed generated by said impeller rotational torque generation section.

15. (New) A centrifugal blood pump apparatus according to claim 14, wherein said control mechanism maintains a constant distance between said impeller and said housing by changing the degree of the impeller-attracting force of said electromagnet according to the rotation speed generated by said impeller rotational torque generation section.

16. (New) A centrifugal blood pump apparatus according to claim 13, wherein the control mechanism reduces an attractive force of said electromagnet to a value less than said predetermined value after said impeller rotational torque generation section starts to rotate.

17. (New) A centrifugal blood pump apparatus according to claim 13, wherein a corner of said hydrodynamic pressure groove is chamfered to allow said corner to have a radius of rounding at not less than 0.05 mm.

18. (New) A centrifugal blood pump apparatus comprising:
a housing having a fluid inlet port and a fluid outlet port;
a centrifugal pump section including an impeller having a first magnetic material therein and rotatable inside said housing to feed a fluid by a centrifugal force generated during a rotation thereof;
an impeller rotational torque generation section for attracting and rotating said impeller;
and a hydrodynamic pressure groove formed at a portion of an inner surface of said housing at an impeller rotational torque generation section side or at a portion of a surface of said impeller at said impeller rotational torque generation section side;
said impeller being rotatable without contacting said housing owing to an action of said hydrodynamic groove;
an electromagnet for attracting said first magnetic material of said impeller or a second magnetic material provided on said impeller separately from said first magnetic material in a direction opposite to a direction in which said impeller

rotational torque generation section attracts said first magnetic material and helping said impeller levitate;

a control mechanism for controlling said impeller rotational torque generating section and said electromagnet, said control mechanism starting rotation of said impeller rotational torque generating section with said electromagnet attracting said impeller thereto at a force not less than a predetermined value; and

wherein said centrifugal blood pump apparatus has a second hydrodynamic pressure groove formed at a portion of an inner surface of said housing at a electromagnet-disposed side or at a portion of a surface of said impeller at said electromagnet-disposed side.

19. (New) A centrifugal blood pump apparatus according to claim 18, wherein a corner of said second hydrodynamic pressure groove is chamfered to allow said corner to have a radius of rounding at not less than 0.05 mm.

20. (New) A centrifugal blood pump apparatus according to claim 18, wherein the control mechanism changes a degree of an impeller-attracting force of said electromagnet according to a rotation speed generated by said impeller rotational torque generation section.

21. (New) A centrifugal blood pump apparatus according to claim 20, wherein said control mechanism maintains a constant distance between said impeller and said housing by changing the degree of the impeller-attracting force of

said electromagnet according to the rotation speed generated by said impeller rotational torque generation section.

22. (New) A centrifugal blood pump apparatus according to claim 20, wherein said control mechanism monitors electric current of said impeller rotational torque generation section and controls said electromagnet by using an electric current value detected by said control mechanism.